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ARTIFICIAL RESEEDING ON OAK-BRUSH RANGE IN CENTRAL UTAH

By

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By RAYMOND PRICE,[1] *associate forest ecologist, Intermountain Forest and Range Experiment Station, Forest Service* [2]

CONTENTS

INTRODUCTION

Oak-brush ranges occupy a large part of the lower mountain slopes within the intermountain region and form a vital part of that range territory. Livestock graze these ranges twice during a normal grazing season and often remain within them throughout the season. Thus, they form an important two-way forage connecting link between the higher mountain summer and the lower early spring-fall and winter ranges. Because of recent drought and heavy grazing use which has accompanied it, the grazing capacity of these oak-brush ranges has been greatly reduced. Less valuable shrubby species, chiefly big sagebrush (*Artemisia tridentata* Nutt.) and gambel oak (*Quercus gambelii* Nutt.) are replacing the more palatable forage grasses. The fertile topsoil is being carried away by accelerated water erosion, leaving exposed "sore spots" and denuded ridges. The native palatable herbaceous vegetation on thousands of acres is so far depleted that revegetation by natural means, even with restricted livestock grazing, is difficult and impractical. Therefore, if these oak-brush ranges are to furnish their maximum forage value, artificial reseeding must be a necessary part of conservation programs designed to rehabilitate them.

[1] Credit is due C. L. Forsling, Assistant Chief, Forest Service, in charge Forest Research, formerly director of the Intermountain Forest and Range Experiment Station, under whose direction the study was carried on; to E. W. Nelson, Colorado State College, who conducted a part of the field work; to J. M. Hockaday, ranger, Lemhi National Forest, who aided in the compilation of the data; and to George Stewart, Intermountain Forest and Range Experiment Station, who contributed valuable assistance in the preparation of the manuscript.

[2] Investigations with sweetclovers (*Melilotus alba* Desr. and *M. officinalis* (L.) Lan. and D. C.) and crested wheatgrass (*Agropyron cristatum* (L.) Beaur.) were made in cooperation with the U. S. Bureau of Plant Industry.

Successful restoration of range forage grasses by artificial reseeding on depleted mountain meadows, alluvial bottoms, and the better sites of mountain slopes where soil and moisture conditions are above average, has been reported by Griffiths (*7*),[3] Cotton (*5*), Sampson (*21*), and others, and summarized by Forsling and Dayton (*6*). Similar results were obtained by Wilson (*29*) on New Mexico ranges and by Hanson (*9, 10*) on waste range land and pasture land used for spring–fall mountain grazing in Colorado. Christ (*2*) has reported success in reseeding burned-over lands in northern Idaho; and many recent observations on dry farms indicate that reseeding such lands is practical (*20*). These studies are fortified by numerous publications on the value of forage crops and their adaptation under cultivated conditions. It is clear from these experiences that artificial range and pasture reseeding is practicable if species adapted to the natural conditions of the site are selected and where protection from livestock grazing and other detrimental factors allows for the proper establishment and maintenance of the introduced vegetation.

The results of artificial reseeding trials made on the better sites of an oak-brush range which has moderately favorable soil and moisture conditions are presented in this circular. These tests were made in Ephraim Canyon in central Utah, during the period 1928 to 1935, inclusive, by the Great Basin branch of the Intermountain Forest and Range Experiment Station.

PHYSIOGRAPHIC FEATURES, VEGETATION, AND CLIMATE OF THE EXPERIMENTAL AREA

The experimental range, occupying a belt of land of varying width between the elevations of 6,500 and 8,000 feet, is located on the west slope of the Wasatch Plateau. Its profile drops rather abruptly to the west. The angle of slope is diversified by minor inequalities, which, however, are not of sufficient magnitude to mask the general slope (pl. 1).

The vegetation is typical of oak-brush ranges, consisting chiefly of Gambel oak (*Quercus gambelii*) interspersed with bigtooth maple (*Acer grandidentatum* Nutt.) and common serviceberry (*Amelanchier alnifolia* Nutt.) with a small number of under shrubs, chiefly big sagebrush (*Artemisia tridentata*), birchleaf mountain-mahogany (*Cercocarpus montanus* Raf.), and bitterbrush (*Purshia tridentata* (Pursh) DC.). Big sagebrush often forms dense stands in the comparatively small openings, usually with a moderate mixture of grass and weed species, chiefly Letterman needlegrass (*Stipa lettermani* Vasey), slender wheatgrass (*Agropyron pauciflorum* (Schwein.) Hitchc.), mutton bluegrass (*Poa fendleriana* (Stend.) Vasey), western yarrow (*Achillea lanulosa* Nutt.), pentstemons (*Pentstemon* spp.) and asters (*Aster* spp.).

Normal annual precipitation near the center of the range totals 17.51 inches, of which 62 percent falls during the winter season (Oct. 1 to Apr. 30) (*19*). However, annual precipitation during the experimental period (1928–35) was 30 percent below normal except in 1930. Mean monthly precipitation varies from 0.69 inch in June to 1.92 inches in March. Temperatures vary greatly, with extremes of 97° F. and −30°, although the mean yearly temperature is 42.6°. July and August are the warmest months, during which temperatures

[3] Italic numbers in parentheses refer to Literature Cited, p. 17.

reach 79° F. or higher during the day and drop no lower than 48° at night, with a daily range of 30°.

METHODS OF STUDY

AREAS SELECTED

Three areas, located at different elevations within the experimental range, were fenced for use in the study. Location and description of these areas are given in table 1.

TABLE 1.—*Areas selected for artificial reseeding on oak-brush range in central Utah, 1928–35*

Area	Location	Vegetational cover	Elevation	Average annual precipitation	Aspect	Soil type	Size
			Feet	*Inches*			*Acres*
Lower	Lower limits of oak-brush zone.	Heavy sagebrush	7,150	12	SW	Clay	12
Middle	Middle oak-brush zone.	Oak brush sagebrush.	7,890	17	SW	do	42
Upper	Upper limits of oak-brush zone.	Sagebrush oak brush.	8,000	20	WS	do	10

Soils of the three areas are mainly of limestone origin with the following percentages of clay: Lower, 30; middle, 38; and upper, 33. The soils of the middle and upper areas are higher in nitrogen and organic matter and have a higher moisture equivalent than those of the lower area (table 2).

TABLE 2.—*Analyses of soils of artificial reseeding areas on oak-brush range in central Utah*

Area	Clay	Nitrogen	Organic matter	Moisture equivalent[1]
	Percent	*Percent*	*Percent*	
Lower	30	0.296	5.8	26.7
Middle	38	.352	7.4	32.7
Upper	33	.344	7.8	31.0

[1] The percentage of water retained by a soil when a layer of that soil 1 centimeter deep is centrifuged for 40 minutes at a speed of 2,440 revolutions per minute, the centrifugal force being 1,000 times that of gravity.

SPECIES AND SOURCES OF SEED

The species used in the study were:

Crested wheatgrass (*Agropyron cristatum*), a hardy, long-lived perennial bunchgrass introduced into the United States from dry plains of Asiatic and European Russia (now the Union of Soviet Socialist Republics). This species is remarkable for its tolerance of great fluctuations of temperatures, for early spring growth, and for its ability to grow in a great variety of soils. It is highly palatable to all classes of livestock, nutritious, and very resistant to drought (*6*, *13*, *25*, *27*, *28*).

Smooth brome (*Bromus inermis* Leyss), sometimes called Austrian, awnless, common, field, Hungarian, or Russian brome, is a long-lived perennial grass with running rootstocks. Smooth brome, a native of Europe ranging from central Europe to China, was introduced

into North America about 1880. It has been grown in Alaska and southern Canada and in the United States as far south as Tennessee, Kansas, and California. It is highly palatable to all classes of livestock, produces abundant nutritious foliage, matures a large amount of viable seed, and grows well in various soils and at various altitudes, although it produces little viable seed at altitudes of 10,000 feet or more (*6, 14, 16, 18, 22, 25*).

Mountain brome (*Bromus carinatus* Hook. and Arn.), a rather variable species, has been regarded by some botanists as composed of three separate species—California brome (*B. carinatus*), big brome (*B. marginatus*), and polyanthus brome (*B. polyanthus*). These were frequently lumped together in the Forest Service under the group name "big mountain bromes," and are now considered as one species designated as mountain brome (*11*). This is a short-lived perennial bunch grass, rather widely distributed in the mountainous regions of the range States. It yields an abundance of nutritious forage, which is relished by all classes of livestock, and produces an abundance of viable seed. It ordinarily grows in scattered bunches but makes a fairly dense stand in this locality (*6, 25*).

Slender wheatgrass (*Agropyron pauciflorum*) was until recently generally regarded as two separate species, slender wheatgrass (*A. tenerum*) and violet wheatgrass (*A. violaceum*) (*11*). Slender wheatgrass is a perennial bunchgrass, widely distributed, ranging from Newfoundland to Alaska and south to Missouri, Kansas, New Mexico, and California. It is typical of mountainous regions and grows well in various soils. It is highly palatable to all classes of livestock, very nutritious, starts growth early in the spring, and produces an abundant foliage growth (*6, 25*).

White sweetclover (*Melilotus alba*), sometimes known as bee-clover, honey clover, and white melilot, is a biennial herb belonging to the pea family. It is native to the temperate regions of Europe and Asia and was introduced into the United States about 1739. White sweetclover is adapted for cultivation in a wide variety of climatic conditions, is drought-resistive, outstanding for early spring growth, and palatable to all classes of livestock (*25*). It is especially valuable as a soil improver and has been studied by numerous investigators under many conditions (*1, 3, 4, 6, 12, 15, 17, 18, 23, 26*).

Yellow sweetclover (*Melilotus officinalis*), sometimes known as yellow melilot, also is a biennial herb. It is native to Europe and Asia but now is widely distributed in North America (*25*). The growth habits and characteristics of yellow sweetclover are similar to those of white sweetclover, except that yellow sweetclover matures earlier, produces more seed, is more aggressive, has greater resistance to grazing, and is more tolerant to heat and drought (*1, 3, 4, 6, 12, 15, 17, 18, 23, 26*).

Practically all of the sweetclover seed and part of the crested wheatgrass seed used in the experiment was furnished by the Bureau of Plant Industry. The balance of the seed of these species and all of the smooth brome seed came from various commercial seed houses. The seed of the two native grass species, slender wheatgrass and mountain brome, was collected in the vicinity of the experimental areas.

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A portion of the oak-brush zone of the Wasatch Plateau within which the middle experimental area is located.

F312744

A stand of crested wheatgrass at the middle experimental area.

METHODS OF SOWING

SOWING AND SOIL TREATMENT TESTS

The following methods of sowing and soil treatment were used in the main:

(1) Seed sown broadcast by hand on plowed furrows,[4] spaced approximately 3 feet apart and covered with soil by use of a brush drag; 86 tests.

(2) Seed sown broadcast by hand on unprepared ground and trampled in by sheep; 13 tests.

In addition, three or more tests were made under the following methods:

(3) Seed sown broadcast by hand on unprepared ground with no further treatment; nine tests.

(4) Seed sown broadcast on snow with no further treatment; four tests.

(5) Seed sown on plowed furrows, spaced approximately 3 feet apart, with no further treatment; three tests.

AMOUNT OF SEED USED

The amount of seed used varied from 9 to 13 pounds per acre for the sweetclovers and from 9 to 16 pounds per acre for the grass species.

TIME OF SOWING

Four plots were sown in the fall of 1928, and 28 in the spring (May and June) and 54 in the fall (October) of 1929. Eleven plots were sown in the spring and 9 in the fall of 1930, and 12 in the spring of 1931.

SIZE OF PLOTS

The sizes of the test plots, which varied owing to local differences in vegetation and topography, were as follows: 0.12 acre at the lower area, 0.13 acre and 0.34 acre at the middle area, and from 0.12 acre to 0.72 acre at the upper area.

GRAZING TREATMENT

The two lower areas were grazed by 15 cattle in 1931 and 1934. The grazing periods did not last more than 2 days at any one time and were delayed until after seed maturity of the grass species to insure trampling-in of the seed. Utilization in 1931 averaged 77 percent for the grass species and 67 percent for the sweetclovers, while in 1934 it averaged 55 percent for all species including sweetclovers. The upper area was not grazed by livestock during the experimental period.

In addition to the grazing by livestock, the grasses on all three areas were heavily cropped by deer [5] and rodents.[6] Grazing by deer was noticeable on all areas throughout each year; it was heaviest at the two lower areas in the early spring, when the plants were green, and again in the fall, when snow was present at the higher altitudes. Rodent damage was excessive in all years except 1933. In 1932

[4] The test areas were comparatively flat and heavily vegetated with brush species, so that there was no threat of soil erosion as the result of plowing. The furrows were therefore plowed parallel with the long dimension of the plots.

[5] Mule deer (*Odocoileus hemionus*).

[6] Chiefly black-tailed jack rabbit (*Lepus californicus*), chipmunks (*Eutamias* spp.), and pocket gophers (*Thomomys* spp.). Also, northern mantled ground squirrels (*Callospermophilus* spp.), and gray ground squirrels (*Citellus* spp.).

rodents clipped from 75 to 100 percent of all mature grass seed heads. Damage was particularly heavy on crested wheatgrass, which was completely clipped of seed heads just prior to normal seed maturity.

FIELD MEASUREMENTS

The following field measurements were made: Regular observations of 1- by ¼-meter seedling plots to determine the establishment and survival of the seedlings; ocular estimates of plant densities by the point-observation-plot method (*24*) to determine the rate of increase or decrease of the established plants; and height-growth measurements to evaluate the vigor of the plants. In addition, several photographs of the plots were taken; germination tests were made of the seeds produced; and regular ocular observations of grazing use were made.

RESULTS

RESPONSE OF SPECIES

CRESTED WHEATGRASS

Of the 25 tests made with crested wheatgrass (pl. 2), 8 produced good stands,[7] 14 fair stands,[8] and 3 poor stands (tables 3, 4, and 5). Nine of the twenty-two plots producing fair to good stands were sown in the spring and 13 in the fall; 18 were sown broadcast on plowed furrows and the seed covered by use of a brush drag; 2 were seeded by the broadcast method and trampled by sheep; 1 was sown broadcast on plowed furrows with no further treatment; and 1 was sown broadcast on unprepared ground with no further treatment.

TABLE 3.—*Species, time, and methods of sowing and stands obtained from reseeding trials on lower area of oak-brush range in central Utah, 1929–35*

Species	Season and year sown	Stands obtained			
		Seed sown on plowed furrows and brushed in			Seed sown on plowed furrows with no further treatment
		Good	Fair	Poor to nil	Fair
		Number	*Number*	*Number*	*Number*
Crested wheatgrass	Fall, 1929	1	2		
	Spring, 1930		1		
	Fall 1930	1			1
	Spring 1931		1		
Smooth brome	Fall 1929	1			
	Spring 1930	1			
	Fall 1930		1		
	Spring 1931		1		
Mountain brome	Fall 1929	1			
	Spring 1930		1		
	Spring 1931	1			
White sweetclover	Fall 1929			4	
	Spring 1930			1	
Yellow sweetclover	Fall 1929			4	
	Spring 1930			1	
	Fall 1930			1	
	Spring 1931			1	
Total	Spring	2	4	3	
	Fall	4	3	9	1

[7] Plots on which the seeded species constituted 40 percent or more of available vegetation throughout the plot area.

[8] Plots on which the seeded species constituted 40 percent of available vegetation in scattering stands, or an average of 25 percent throughout the plot area.

TABLE 4.—*Species, time, and methods of sowing and stands obtained from reseeding trials on middle area of oak-brush range in central Utah, 1929–35*

Species	Season and year sown	Stands obtained								
		Seed sown on plowed furrows and brushed in			Seed sown broadcast and trampled by sheep			Seed sown broadcast only	Seed broadcast on snow	Seed sown on plowed furrows
		Good	Fair	Poor to nil	Good	Fair	Poor to nil	Poor	Poor	Poor
		Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Crested wheatgrass	Spring 1929	1			1	1				
	Fall 1929	3	2	1						
	Spring 1930		1							
	Fall 1930		1							
	Spring 1931		1						1	
Smooth brome	Spring 1929	1				2				
	Fall 1929	1	1							
	Spring 1930		1							
	Fall 1930			1						
	Spring 1931		1						1	
Mountain brome	Spring 1929		1				2			
	Fall 1929	1	1							
	Spring 1930		1							
	Spring 1931								1	
Slender wheatgrass	Fall 1929	2								
	Spring 1931	1								
White sweetclover	Spring 1929			1			5			
	Fall 1929			8				1		1
	Spring 1930			1						
Yellow sweetclover	Spring 1929			1			2			
	Fall 1929			6				1		1
	Spring 1930			1						
	Fall 1930			1						
	Spring 1931			1					1	
Total	Spring	3	6	5	1	3	9		4	
	Fall	7	5	17				2		2

TABLE 5.—*Species, time, and methods of sowing and stands obtained from reseeding trials on upper area of oak-brush range in central Utah, 1928–35*

Species	Season and year sown	Stands obtained				
		Seed sown on plowed furrows and brushed in			Seed sown broadcast with no further treatment	
		Good	Fair	Poor to nil	Fair	Poor to nil
		Number	*Number*	*Number*	*Number*	*Number*
Crested wheatgrass	Spring 1929	1			1	
	Fall 1929		2	1		
Smooth brome	Spring 1929	1			1	
	Fall 1929	1				
Mountain brome	Spring 1929	1			1	
	Fall 1929	1				
White sweetclover	Fall 1928			1		1
	Spring 1929			1		1
	Fall 1929			4		
Yellow sweetclover	Fall 1928			1		1
	Spring 1929			1		1
	Fall 1929			1		
	Fall 1930			1		
Total	Spring	3		2	3	2
	Fall	2	2	9		2

Viable seed having an average germination of more than 90 percent was matured on all 22 plots. Plants at the two lower experimental areas were more vigorous and produced greater density, although height growth was greatest at the upper area owing in part to shade (table 6).

The plants withstood grazing use exceptionally well. In spite of the heavy cropping by rodents, which limited the available seed supply for the establishment of new plants, the original plants stooled out and increased the density of the stand. The best stands were obtained in the furrows because of cultivation as the result of plowing and the greater supply of available soil moisture there. However, new plants came in between the furrows and also became established throughout the plot area; trampling by grazing livestock contributed to this result.

The two plots seeded by the broadcast method on unprepared ground and trampled in by sheep tended to produce more even stands throughout the plot area, although the total density of the resulting stands was considerably less than that of the stands obtained from sowings on plowed furrows followed by brushing.

TABLE 6.—*Average height growth of reseeded species at three elevational areas on oak-brush range in central Utah*

Species	Lower area	Middle area	Upper area
	Centimeter	*Centimeter*	*Centimeter*
Crested wheatgrass	53	49	55
Smooth brome	43	47	61
Mountain brome	49	42	68

SMOOTH BROME

All but two of the test plots seeded with smooth brome (pl. 3, *A*, *B*, and *C*) produced fair to good stands (tables 3, 4, and 5). Results of 16 tests made with this species are: 6 plots produced good stands, 8 produced fair stands, and only 2 produced poor stands. Of the 14 tests which produced fair to good stands, 9 were sown in the spring and 5 in the fall; 11 were sown broadcast on plowed furrows and covered by use of a brush drag; 2 were sown broadcast on unprepared ground and trampled by sheep; and 1 was sown broadcast on unprepared ground with no further treatment. On each of the 14 plots that produced fair to good stands seed having a germination of more than 90 percent was matured. The two plots that produced poor stands were sown in an oak type at the middle area, one by broadcasting seed on the snow and the other by broadcasting seed on plowed furrows and covering by use of a brush drag.

Plots seeded to smooth brome produced good stands at all three elevational areas. The vigor of the individual plants, however, as well as height growth, increased with increase in altitude (table 6.)

Because of the running rootstalks characteristic of this grass, the thickest stands were produced in the plowed furrows where the original plants were established. Dense stands also resulted around and under big sagebrush, the shade of which no doubt helped conserve the supply of soil moisture. New plants were established also between the furrows, and the older plants spread out from the furrows; but the

height growth of these exposed plants was considerably less than that of those that grew in the furrows and around the sagebrush.

On all areas smooth brome produced a great abundance of basal foliage growth which was readily eaten by the cattle. Deer and jack rabbits also heavily grazed these stands during each year of the study. Nevertheless, the plants increased in density at all areas during the course of the experiment.

MOUNTAIN BROME

Thirteen experimental plantings were made with mountain brome, with the following results: 5 produced good stands, 5 fair stands, and 3 poor stands. Of the 10 tests having some degree of success, 6 were sown in the spring and 4 in the fall. The four test plots planted in the fall, however, were all successful while the three plots that produced poor stands, two of which were trampled by sheep, were all planted in the spring. Nine of the ten successful plots were sown broadcast on plowed furrows and covered by use of a brush drag, and the other was sown broadcast on untreated ground with no further treatment.

Mountain brome is native to Ephraim Canyon, though it generally grows in open parks and parklike areas within the aspen-fir zone which extends from 7,500 to 9,000 feet elevation. This species grew and produced viable seed at all of the experimental areas, although it attained its maximum vigor and height growth at the upper area (pl. 4). It withstood cattle and deer grazing and rodent cropping at the two lower areas and increased its original density during the course of the experiment. The denser stands were produced in the plowed furrows and around the brush species, but the older plants spread out and a few plants were established between the furrows.

SLENDER WHEATGRASS

Three tests were made with slender wheatgrass. The sowings, which were made at the middle area (pl. 5), were by the broadcast method on plowed furrows and covered by use of a brush drag. All produced good stands supporting vigorous plants that matured viable seed. Two were fall sowings, and one spring.

Slender wheatgrass is native to Ephraim Canyon and grows throughout all vegetational zones common to this locality, reaching its maximum growth above 8,000 feet. The results of these few tests, however, indicate that this species grows well also in the middle oak-brush zone.

WHITE SWEETCLOVER

All trials made with white sweetclover, irrespective of location, soil treatment, or season of planting, produced poor or no stands (tables 3, 4, and 5). Ten of the thirty tests made with white sweetclover had good germination, and produced stands for the first 2 years, but only six plots maintained plants thereafter. Of these six test plots, all were sown in the fall (October); four were at the upper area and one each at the two lower areas. On three of the four plots that maintained stands at the upper area, the seed was sown broadcast on plowed furrows and covered by use of a brush drag. The seed for the other plot was sown broadcast on unprepared ground with no further treatment. In both plantings at the lower areas the seed was sown broadcast on plowed furrows and covered by use of a brush drag.

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Since white sweetclover is a biennial plant and is dependent upon its ability to produce seed to maintain a stand, it is possible that rodents may have destroyed some of the seed produced. However, rodent damage to the sweetclover plants was not excessive. Also since the parts of the test plots on which plants were maintained were in swales or low areas where soil moisture was above average, it is believed that the low soil moisture was the limiting factor for the survival of this plant.

Altitude apparently was not the influencing factor since good stands were obtained at higher altitudes where soil moisture is greater (pl. 6)

YELLOW SWEETCLOVER

Results of trials made with yellow sweetclover were similar to those with white sweetclover. Of the 28 experimental plantings made, 22 failed to produce and 6 produced poor stands. However, yellow sweetclover showed better germination and longer survival than did white sweetclover. Seedling counts show that 14 of the 28 tests had good germination and some plants survived the first 2 years. Of the six plots that supported established plants throughout the study, three were on the upper, two on the middle, and one on the lower area. All were sown broadcast on plowed furrows and the seeds were covered by use of a brush drag except on one plot at the upper area where the seeds were broadcast on unprepared ground with no further treatment. All tests were made in the fall (October), except one at the middle area which was made in the spring (June).

There was some rodent damage to the yellow sweetclover plants, but it was not excessive. It is believed that the limiting factor for the proper survival of this species also was the variable soil moisture together with the relatively unfavorable soil conditions, since the stands that were maintained were on sites where soil and moisture conditions were above average.

COSTS OF SOWING

The costs of sowing of the various soil treatments used, exclusive of the cost of seed, were as follows:

	Cost per acre
Method 1 (Seed sown broadcast by hand on plowed furrows, spaced at approximately 3 feet, and covered by use of a brush drag.)	$6.00
Method 5 (Seed sown broadcast by hand on plowed furrows, spaced at approximately 3 feet, with no further treatment.)	4.50
Method 2 (Seed sown broadcast by hand on unprepared ground and trampled by sheep.)	.80
Method 3 (Seed sown broadcast by hand on unprepared ground with no further treatment.)	.65

No cost figures are available for method 4 (seed sown broadcast on snow), but, no doubt, they are comparable to those of method 3. All costs are for relatively small plots and undoubtedly would be reduced if used on large-scale operations.

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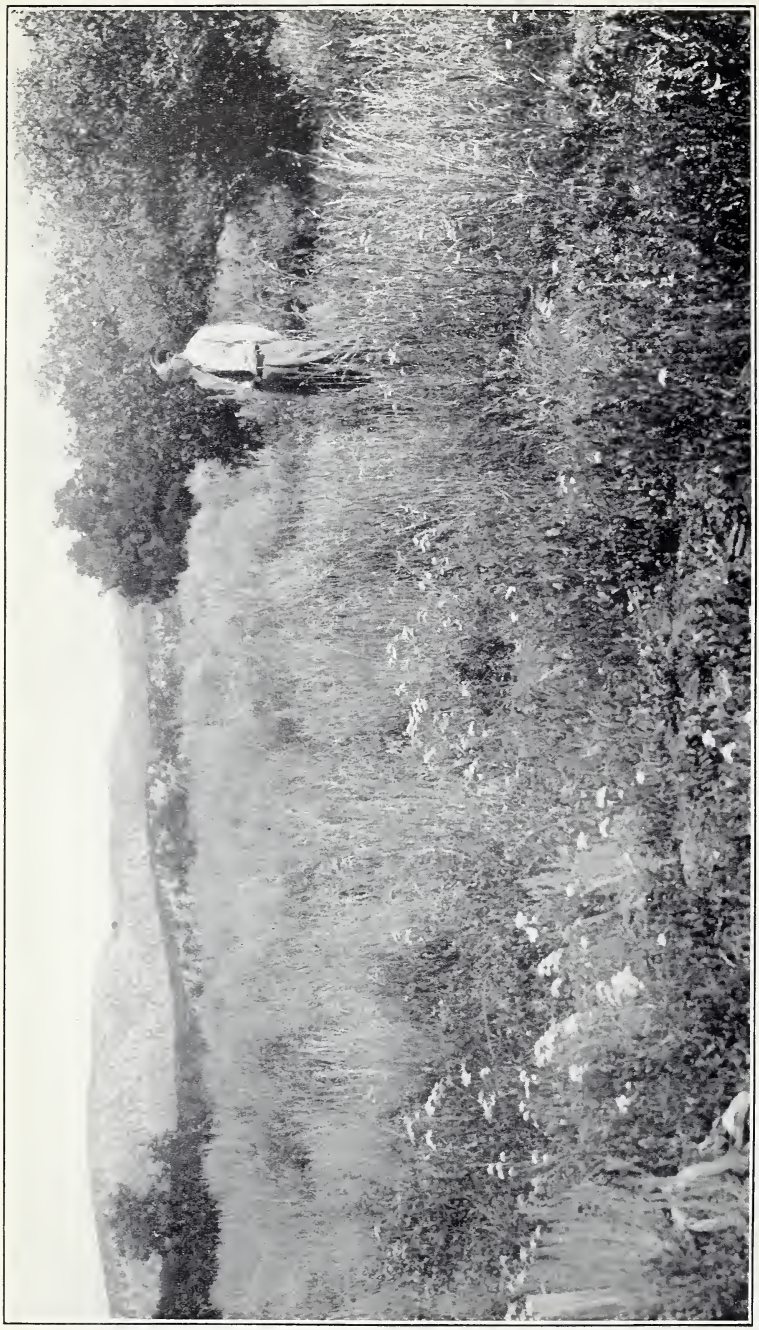
Stands of smooth brome at *A*, the upper experimental area, *B*, the middle area, and *C*, the lower area.



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A stand of mountain brome at the upper experimental area.

F264447

A close-up of a stand of slender wheatgrass at the middle experimental area.

F264462

A stand of white sweetclover growing in an experimental nursery at an elevation of 8,850 feet, Ephraim Canyon, Utah.

INCREASE IN GRAZING CAPACITY[9]

Marked increases in grazing capacity of the experimental plots occurred at all areas as the result of reseeding artificially with mountain brome, crested wheatgrass, and smooth brome on plowed furrows and covering by use of a brush drag. Increases also resulted at the middle area from similar sowings of slender wheatgrass, and by broadcasting seed of crested wheatgrass and smooth brome on unprepared ground followed by trampling by sheep (fig. 1, *A*, *B*, and *C*).

The grazing capacity of plots sown to mountain brome by broadcasting seed on plowed furrows followed by covering by use of a brush drag increased an average of 2.75 cow-months per 50 acres, or 367 percent, at the lower area; 2.5 cow-months per 50 acres, or 71 percent, at the middle area; and 5 cow-months per 50 acres, or 250 percent, at the upper area,[10] over the respective open-grazed, unseeded plots. Similarly, the grazing capacity of plots seeded to crested wheatgrass gave increases of 3.25 cow-months, or 433 percent, at the lower area; 3.5 cow-months, or 100 percent, at the middle area; and 5 cow-months, or 250 percent, at the upper area, while plots seeded to smooth brome yielded increases of 6.25 cow-months, or 933 percent, at the lower; 4.5 cow-months, or 129 percent, at the middle; and 5 cow-months per 50 acres, or 250 percent, at the upper area (fig. 1, *A*, *B*, and *C*). Plots seeded to slender wheatgrass gave an increase of 3 cow-months per 50 acres, or 86 percent, at the middle area, the only place it was sown (fig. 1, *B*).

Plots seeded to crested wheatgrass and smooth brome by broadcasting seed on unprepared ground followed by trampling by sheep at the middle area, the only place tests were made with this method, yielded increases of 2 cow-months per 50 acres, or 57 percent, over the open, grazed, unseeded plots (fig. 1, *B*).

The grazing capacity furnished by the various species sown varied with location and with the species used (fig. 1, *A*, *B*, and *C*). For example, smooth brome alone furnished an average of 86 percent of the total grazing capacity of the plots on which it was seeded at the lower area, 63 percent and 11 percent, depending upon the method of sowing, at the middle area, and 57 percent at the upper area. On the other hand, crested wheatgrass alone furnished 60 percent of the total grazing capacity of its plots at the lower area, 50 percent and 29 percent at the middle area, and only 14 percent at the upper area, while mountain brome alone furnished 43 percent at the lower, 22 percent at the middle, and 36 percent at the upper area. Slender wheatgrass alone furnished 35 percent of the total grazing capacity of the plots on which it was sown.

The balance of the grazing capacity of the various reseeded plots was furnished by the increase of the native vegetation, chiefly bluestem wheatgrass (*Agropyron smithii* Rydb.) at the two lower areas and bluebunch wheatgrass (*A. spicatum* (Pursh.) Scribn. and Smith), slender wheatgrass, and weeds at all areas. The native vegetation on practically all plots, except those seeded to smooth brome, showed

[9] Grazing capacities are based on ocular estimates and do not represent pasture tests. However, the estimates offer a uniform basis for comparison. All estimates of grazing capacities were made in 1935, at the end of the sixth growing season for the majority of the plots. An insufficient number of tests was made by broadcasting seed on unprepared ground and broadcasting seed on plowed furrows without further treatment to warrant estimates of grazing capacities. All tests made by broadcasting seed on snow failed to produce.

[10] Increases in grazine capacities of the experimental plots at the upper area may be high in comparison to those at the 2 lower areas, since the upper area was not grazed by livestock.

significant increases over the unseeded plots (fig. 1, *A*, *B*, and *C*). This increase, no doubt, was the result of restricted livestock grazing in addition to cultivation caused by the soil treatments. The stands produced by smooth brome were apparently dense enough to prohibit any great increase of native vegetation.

DISCUSSION OF RESULTS

SUITABLE SPECIES

Notwithstanding heavy rodent damage and extreme drought during the experimental period, good stands of smooth brome, mountain brome, crested wheatgrass, and slender wheatgrass were obtained at the elevational stations within the experimental oak-brush range.

Smooth brome especially proved to be suitable for reseeding oak-brush ranges similar to the experimental range, since this species not only produced excellent foliage growth but also matured an abundant supply of viable seed at all areas. Because of the nature of its spreading basal foliage growth and its ability to reproduce vegetatively as well as by seed, this species is exceptionally suitable for reseeding grazed and/or eroded areas (pl. 3).

Since the stands of crested wheatgrass obtained from sowings made at the upper experimental area were less dense than the stands obtained at the two lower areas, and the plants at the upper area were less vigorous, it is clear that crested wheatgrass is more suitable for artificial reseeding below 8,000 feet elevation.

Mountain brome and slender wheatgrass, the two native grasses, also proved to be suitable for general reseeding of similar oak-brush ranges. Mountain brome will do best at higher and slender wheatgrass at lower elevations. Two other native species, bluestem wheatgrass and bluebunch wheatgrass, also proved to be suitable for reseeding similar oak-brush ranges, since these two species increased by natural revegetation within the experimental areas.

UNSUITABLE SPECIES

Evidence from the study definitely shows that yellow and white sweetclovers are not suitable for general reseeding of similar oak-brush ranges. Some success may be obtained by sowing these two species on sites where moisture and soil conditions are above average, but resowing will be necessary to maintain satisfactory stands.

SEASON TO SOW

The most favorable season to reseed artificially similar oak-brush ranges depends to a large extent upon the seasonal precipitation. Almost equally good results were obtained from both spring and fall sowings when precipitation after planting was normal or above. However, on the average, fall sowings are more reliable, since precipitation is reasonably assured during early spring when the seedlings are becoming established.

A recent study of germination requirements of western range plants [11] indicates that the season of planting may vary with the species used inasmuch as each species has its own individual germination require-

[11] Unpublished data from seed germination studies of western mountain range plants made by S. M. Griswold for the Intermountain Forest and Range Experiment Station.

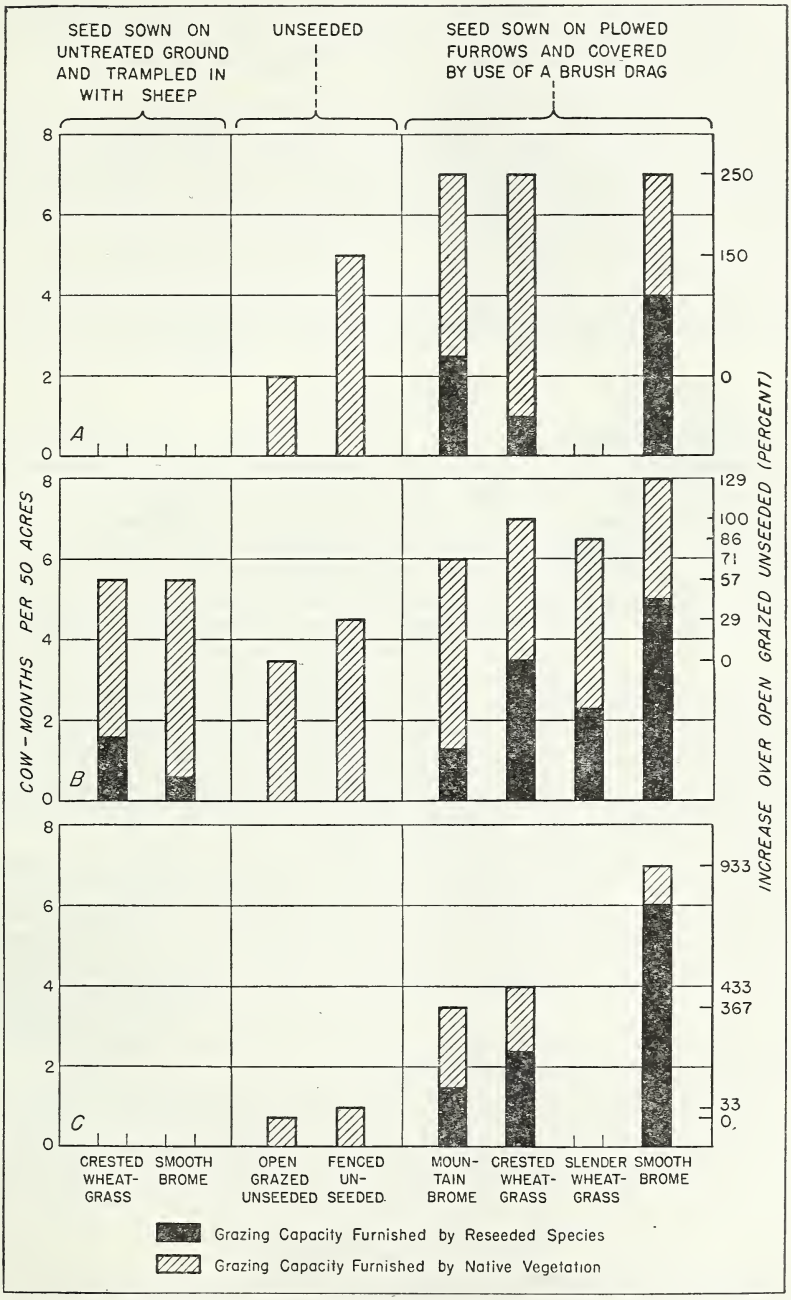

FIGURE 1.—Grazing capacity of open grazed unseeded, fenced unseeded, and reseeded experimental plots on oak-brush range in Ephraim Canyon, Utah, 1935: *A*, Upper area; *B*, middle area; *C*, lower area.

ments. This study shows that seed of mountain brome has a dormant period of 3 to 4 months after seed maturity before it will germinate, whereas seed of slender wheatgrass is capable of germination soon after dissemination when subjected to cold, suggesting that the fall is the best season to sow slender wheatgrass and spring the best season to sow mountain brome.

Other studies (*8*) show that seed of mountain brome gave a germination of 98 percent under continuous moisture, while seed of slender wheatgrass gave a germination of only 6 percent under identical conditions. With alternate moistening and drying, seed of mountain brome gave the same percentage of germination, whereas seed of slender wheatgrass gave from 2 to 4 percent germination under the same conditions. These results indicate that slender wheatgrass will germinate better on drier sites than mountain brome and also emphasize the importance of information regarding the germination requirements of seed to be used in artificial range reseeding.

METHODS TO USE

Since in nearly 75 percent of the total number of tests made seed was sown by method 1 (seed sown broadcast on plowed furrows and covered by use of a brush drag) and in the remaining 25 percent sowing was by one of the four other methods, it is impossible to make adequate comparison between the methods used. However, it is clear that the best stands were obtained by method 1.

Of the 44 tests made with the grass species with this method, 21, or 48 percent, produced good stands; 20, or 45 percent, produced fair stands; and 3, or 7 percent, produced poor stands. Of the six tests made with the grass species by broadcasting seed on unprepared ground followed by trampling by sheep, one produced a good stand, three produced fair stands, and two poor stands. All three tests made with the grass species by broadcasting the seed on unprepared ground with no further treatment produced fair stands. The single test made with a grass species by broadcasting the seed on plowed furrows with no further treatment produced a fair stand.

The results of the few tests made by broadcasting seed on unprepared ground and trampling by sheep (method 2), and by broadcasting seed on unprepared ground with no further treatment (method 3) indicate that fair stands of grasses may be produced on the better sites of oak-brush ranges where the soil is deep, fertile, and of medium to fine texture, by the use of these methods. The low costs, 80 and 65 cents per acre, respectively, for these methods are within the practical limits for extensive range reseeding and make them particularly desirable on the better soil types.

Six dollars per acre, plus the cost of seed and protection from livestock grazing during the period of establishment, the cost of small-scale experimental plantings by method 1, makes extensive range use of this method prohibitive. Nevertheless, the results of the study definitely show that fair to good stands are practically assured by this method, and that some degree of soil preparation and covering the seed are necessary on sites where soil conditions are average or below in depth and texture if reseeding is to be successful on similar oak-brush ranges.

FAVORABLE LOCATIONS FOR RESEEDING

Reseeding the grass species used in the study by method 1, seed sown broadcast on plowed furrows and covered by use of a brush drag, was successful in heavy sagebrush cover types, sagebrush-oak brush cover types, and the better sites of the oak brush-sagebrush cover types on the experimental oak-brush range. Fair stands were produced both by method 2, broadcasting seed of the grass species on unprepared ground followed by trampling by sheep, in the oak brush-sagebrush cover type at the middle area, and method 3, broadcasting seed on unprepared ground with no further treatment, in the sagebrush-oak brush cover type at the upper area. The practical application of such reseeding trials on similar oak-brush ranges, however, will vary for each site. The demand for the restoration of a vegetational cover, the degree of soil depletion, the extent of depletion of the native plant cover, and the facilities available must be considered in justifying any reseeding undertaking.

As shown in figure 1, *C*, the grazing capacity of experimental plots at the lower area was increased from 367 to 933 percent during the period 1928–35 by reseeding the various grass species, in contrast to an increase of only 33 percent on the unseeded plots during the same period. This area has been practically denuded of native grasses by past overuse and was of little value for further livestock grazing. The expense of reseeding such areas by broadcasting seed on plowed furrows and covering by use of a brush drag on similar oak-brush ranges appears to be warranted by such marked increases in grazing capacity of the range and by the possibility of the restoration of a more adequate plant cover for protection against soil erosion.

At the upper experimental area (fig. 1, *A*), the increase in grazing capacity of the unseeded plots amounted to 150 percent as the result of 7 years' protection from livestock grazing, in contrast to 250 percent from reseeding. The remnants of native grasses and the fertile topsoil that remained on this area were sufficient to produce the great natural increase. On such areas, artificial reseeding cannot economically take the place of natural recovery by regulated grazing.

At the middle area, in the oak brush-sagebrush cover type, where soil and moisture conditions generally are more severe, it is questionable whether the results obtained from reseeding warrant the expense involved except on the better sites where success is reasonably assured or where a vegetational cover is necessary for the protection of watershed or other land values.

Where the native palatable plant cover on the better sites of oak-brush ranges has not been materially reduced, reseeding is probably not yet justified and cannot take the place of natural revegetation by regulated grazing because of the expense involved. But on sites where the native palatable plant cover has been depleted beyond a practical limit of recovery and the fertile topsoil is exposed to accelerated erosion, reseeding is justified and necessary.

NEED FOR FURTHER RESEARCH

Present and past studies clearly indicate that additional research in artificial reseeding is necessary and should be directed toward: (1) More adequate determination of the particular species ecologically adapted to specific range soil types, with special attention to the possi-

bilities of seeding weed and shrubby species as well as grasses; (2) the possibilities of developing new strains by plant breeding; and (3) development of practicable methods for extensive range application.

SUMMARY

Artificial reseeding trials were conducted by the Great Basin branch of the Intermountain Forest and Range Experiment Station at three different elevational experimental areas on a typical oak-brush range in central Utah. The experimental plots were sown during the period 1928 to 1931 and the last observations reported were made in the fall of 1935.

Crested wheatgrass (*Agropyron cristatum*), smooth brome (*Bromus inermis*), and mountain brome (*B. carinatus*) produced good stands at the lower, middle, and upper experimental areas of the oak-brush range. Crested wheatgrass plants were more vigorous at the two lower areas and smooth brome and mountain brome plants increased in vigor with increase in elevation. Slender wheatgrass (*Agropyron pauciflorum*) produced good stands at the middle area, the only place it was sown. White sweetclover (*Melilotus alba*) and yellow sweetclover (*M. officinalis*) produced poor to no stands at all areas, although both species maintained some plants in swales or low areas where soil and moisture conditions were above average.

The best stands on all plantings were obtained by broadcasting seed on plowed furrows, spaced approximately 3 feet apart and covering by use of a brush drag, at a cost of $6 per acre exclusive of the cost of the seed.

Some fair to good stands of grasses were obtained by broadcasting seed on unprepared ground and by broadcasting seed on unprepared ground followed by trampling by sheep, at costs of 65 cents and 80 cents per acre, respectively, exclusive of the cost of the seed.

A few tests were made by broadcasting seed on plowed furrows with no further treatment, at a cost of $4.50 per acre, exclusive of cost of seed, and by broadcasting seed on snow.

During a period of 7 years the grazing capacity of plots reseeded to grasses by sowing seed on plowed furrows and covering by use of a brush drag, in a heavy sagebrush cover type at the lower experimental area, was increased over that of the open grazed unseeded plots from 367 to 933 percent, depending upon the species sown. Similar data showed increases of from 71 to 129 percent in an oak brush-sagebrush cover type at the upper area. Increases of 57 percent were noted at the middle area from plots reseeded to grasses by broadcasting and trampling by sheep. Some of the increase was due to increase of the native vegetation resulting in part from restricted livestock grazing and in part from cultivation accompanying the sowing treatments.

Practically equally good stands were obtained from both spring and fall sowings when precipitation following planting was normal or above. However, fall sowings are recommended for similar oak-brush areas, since precipitation is more likely to be assured during early spring when the seedlings are becoming established.

That some degree of soil preparation followed by some means of covering the seed is necessary if successful reseeding is to be assured on sites where soil conditions are average or below in depth and texture on similar oak-brush ranges is indicated by the success of the

grass species sown on plowed furrows and covered by use of a brush drag.

The justification of the expense involved in artificial reseeding operations for extensive range use is dependent upon the demand for the restoration of a vegetational cover, the degree of soil depletion, the extent of depletion of the native plant cover, and the facilities available.

Additional research in reseeding is necessary: (1) To determine the species ecologically adapted to specific range soil types; (2) to determine the possibilities of developing new strains by plant breeding; and (3) to develop practicable methods for extensive range application.

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